

APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR : KNUT BENEKE

TITLE: METHOD OF PROCESSING X-RAY IMAGES

ATTORNEYS AND CORRESPONDENCE ADDRESS

VENABLE, BAETJER, HOWARD and CIVILETTI, LLP
P.O. Box 34385
Washington, D.C. 20043-9998
Telephone: (202) 962-4800
Telefax: (202) 962-8300

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CROSS REFERENCE TO RELATED APPLICATION

This application claims the priority of German
5 Application No. 199 16 664.1 filed April 14, 1999, which is
incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 This invention relates to a method of processing X-
ray images. Articles contained in a transilluminated
object are made visible to an operator/observer on a
monitor and markings are placed around earlier-defined
articles.

15 ~~To facilitate the evaluation of an X-ray image of~~
transilluminated objects for an observer, the X-ray image
is automatically examined in the X-ray system based on
various properties. In such an arrangement a software is
searching in the transilluminated object for certain
20 previously defined articles such as firearms, piercing
weapons or explosives.

~~A method of the above-outlined type is described in~~
German Patent document 198 55 250.5. ~~If such an article is~~

detected, the observer receives information that the
article has to be more thoroughly investigated in the
transilluminated object. Such an information is the
marking of the discovered article on the monitor, for
example, by drawing a circle or frame therearound. Since
the detected articles are not recognized as a whole, about
each detected article a marking is placed. An evaluation
by the observer is made difficult if a plurality of such
markings appear on the monitor. Such an event is of
significant disadvantage for the observer if the run-
through period is, for example, approximately 6 seconds.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an
improved method of processing an X-ray image in which the
placed markings are optimized to facilitate the evaluation
of an X-ray image for the observer.

This object and others to become apparent as the
specification progresses, are accomplished by the
invention, according to which, briefly stated, the method
of processing an X-ray image of articles contained in a
transilluminated object and made visible for an observer on

According to an advantageous feature of the invention, joined markings may again be removed, for example, when the operator wishes to see the markings individually. Also, the extent of the combination of the markings may be adjusted. As a result, the markings may be shown unchanged or combined. Further, intermediate steps are possible in which case then maximum 2, 3, 3, 5, etc. markings may be coupled to one another, so that on the monitor two to three markings, etc. may be made visible as individual added markings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified schematic illustration of an X-ray system adapted to perform the method according to the invention.

Figure 2 is a block diagram of a computer system in an X-ray system for performing the method according to the invention.

Figures 3a, 3b and 3c are visual representations for providing a common marking on the monitor.

Figures 4a, 4b and 4c are visual representations of the method for removing the common marking from the monitor.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 illustrates an X-ray system having a conventional X-ray generator 1 and a detector 2, between which an object 3 to be transilluminated is positioned. The object 3 may be a piece of luggage in which various articles 4, 5, 6 are contained. Non-illustrated known components couple a computer system 7 with the detector 2. The measuring results are made visible on a monitor 8 and/or a printer 9 coupled to the computer system 7.

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Figure 2 illustrates the essential component groups of the computer system 7 for performing the method according to the invention. The output of the detector 2 is connected with an image processing device 10 which is, in turn, connected with a marking memory 11 and a memory 12 for the marking lists. The marking memory 11 is bi-directionally connected with the memory 12 and thus gains access to the marking list accumulated during the process. The marking memory 11 is provided with a sub-marking memory

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11.1 which will be described in more detail as the specification progresses.

The method according to the invention is performed as follows:

5 The X-ray generator 1 directs an X-ray beam FX1 to the object 3 to be transilluminated. The X-ray beam FX1 is weakened by the respective absorption behavior of the articles 4, 5, 6 in the object 3 as well as by the housing material of the object 3 and is received by the detector 2.

10 The detector 2, for example, a line camera formed of a plurality of X-ray detectors, produces signals from the non-absorbed part of the X-ray beam and applies the signals, as image data information about the transilluminated object 3, to the computer system 7 for

15 image processing. Such an inputting is performed preferably line-by-line and in a continuous manner. The image data are evaluated in a known manner in the image processing device 10 and are readied for a visual representation on a monitor. An X-ray image represented in

20 this manner is composed of image dots having various properties, for example, a gray scale and material value from which the article 4, 5, 6 may be recognized.

individual added marking M1/3 become sub-markings of the
final added marking Mg. Thus, for the observer there is
obtained a well ascertainable X-ray image on the monitor 8
on which advantageously only a single final added marking
5 Mg is shown without, however, losing the relationships
between the individual markings M1, M2, M3 and the
representation of the final added marking Mg on the monitor
8.

The information concerning the individual markings M1,
10 M2, M3 as well as their assignment as sub-markings in
relation to the individual added marking M1/3 and the final
added marking Mg remain in the computer system 7 in the
memory 12 as well as in the sub-marking memory 11.1. This
makes it possible to again separately display, upon
15 extinguishing the final added marking Mg, all sub-markings
M1 and M3 of the individual added marking M1/3 as well as
the sub-marking M2. For this purpose the final added
marking Mg is removed by the operator from the monitor 8,
for example, by pushbutton operation, whereupon the
20 computer system 7 again renders visible the individual
stored markings M1, M2 (M3 is not shown) on the monitor 8,
as shown in Figures 4a, 4b and 4c.

Such necessary information is taken in steps from the sub-marking memory 11.1 as well as from the marking list in the memory 12. The computer system 7 proceeds with the earlier-described steps in a reverse order. First it is
5 determined which final added marking Mg was removed and the sub-marking memory 11.1 is searched for the individual, associated sub-markings. In this proceeding the sub-marking M1/3 belonging to the final added marking Mg as well as the sub-marking M2 are found. The final added
10 marking Mg is extinguished in the marking list and the sub-marking M1/3 found in the sub-marking memory 11.1 and the sub-marking M2 are added to the marking list of the memory 12. Further, by means of the software of the computer system 7 it is recognized that the sub-marking M1/3, as an
15 individual added marking, is composed of the markings M1 and M3, while the sub-marking M2 has no further sub-markings and thus represents an individual marking. In the marking list the individual added marking M1/3 is extinguished and replaced by the sub-markings M1 and M3
20 which are then inputted from the sub-marking memory 11.1 in the memory 12. The individual markings M1, M2 and M3 are applied to the monitor 8 from the marking list and displayed thereon. In this manner the observer may decide

whether the common marking Mg or the sub-
markings/individual markings M1/3, M2 or only the
individual markings M1, M2, M3, etc. should be shown on the
monitor 8.

5 It is to be understood that upon detection of several
articles, that is, more than the mentioned three articles
4, 5 and 6 the set markings M1, M2 and M3, etc. are
compared with one another as long as no mutually fitting
markings (individual added markings) are found.

10 Several variants are feasible within the scope of the
invention. Thus, the degree and combination of the marking
may be set. With such a setting it may be achieved that
the markings are not always combined or are only partially
combined, that is, intermediate steps with respect to the
15 degree of combination are possible. In this manner too,
individual markings may be removed from the combined
markings which will thus decompose into several parts.

20 It will be understood that the above description of
the present invention is susceptible to various
modifications, changes and adaptations, and the same are
intended to be comprehended within the meaning and range of
equivalents of the appended claims.